

Keeping germplasm flowing

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Introduction

It is increasingly acknowledged that successful adaptation of agricultural production systems to changes in climate will depend upon higher levels of access to and improved use of genetic diversity than is currently the case (Yadav et al. 2011). This is particularly important in light of predictions that climate variability and extreme events will increase globally leading to more risk-prone local growing conditions. The need for improved access and use has been clearly recognized by the international community in the revised Global plan of action for plant genetic resources for food and agriculture (FAO 2011) and, in a more indirect way, in the Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization (Secretariat of the Convention on Biological Diversity 2011). It seems imperative therefore to have intellectual property institutions from local to global levels that do not hamper increased access and use of genetic diversity.

To optimize the contribution of genetic resources to climate change adaptation strategies, it has been argued that new forms of interdisciplinary research, use of new technologies, and novel combinations of partnerships are essential. These new research modalities could be instrumental for developing and/or improving breeding strategies capable of putting useful genetic variation in crop species or varieties at use to strengthen resilience and adaptation of agro-ecosystems to climate change (Snook et al. 2011). Optimal breeding strategies in this direction would be based on timely identification of useful traits, efficient inclusion of the materials that hold these traits in crop improvement programmes and the effective uptake by farmers of the resulting products (Reynolds 2010).

Supportive policies and laws can create an enabling environment for these new modalities of agricultural research and thus contribute to adaptation and ultimately to food security; to date, there are few successful examples to rely on (Pinstrup-Anderson and Watson II 2011). Key questions are i) whether current intellectual property regimes suit climate change adaptation strategies based on the improved use of genetic diversity and ii) whether the search for climate change adaptation strategies based on plant genetic resources is leading to more restrictive intellectual property regimes. There are very few studies that have delved into these questions so far.

The Centres of the Consultative Group on International Agricultural Research (CGIAR), given their mandate, history, and expertise, are expected to play an important role in developing novel agricultural research strategies required to respond to climate change challenges. The Commission on Genetic Resources for Food and Agriculture (CGRFA) of the Food and Agriculture Organization (FAO) lists the CGIAR as one of the key global institutions to develop a roadmap to exploit the potential of genetic resources for climate change adaptation (Commission on Genetic Resources for Food and Agriculture 2010). In addition to the development of specific climate change focused projects by individual CGIAR Centres, the

CGIAR has responded through the development of a new, large, global and multi-year program entitled Climate Change Adaptation and Food Security (CCAFS).

This article describes how eight of the CGIAR Centres whose research is focused on plant genetic resources, are (re)organizing their management of the conservation, improvement and use of crop genetic resources in light of climate change adaptation. The paper also analyses how the collection, use, and distribution of plant genetic resources by the CGIAR is influenced by international and national policies, and international treaties and agreements including concerning intellectual property. The research for the paper was carried out under the CCAFS programme.

One of the main findings of the study is that among CGIAR scientists concerns are on the rise about maintaining continuous access to plant genetic resources globally, including to crop wild relatives that are expected to contain useful traits for crop improvement targeted to new patterns of climate change. Such access is essential for dynamic and adaptive strategies of plant conservation, improvement and use with regard to climate change. The study points to an increasing influence of international and national policies and legal frameworks on all the operations of CGIAR Centres from upstream to downstream levels, affecting genebanks and breeding programmes. It appears that, broadly considered, the institutional environment is becoming less supportive for the efforts of Centres and their partners to continuously access, use and disseminate genetic resources. This may, in the medium and longer term, have a serious impact on the development of (new) strategies to adapt to climate change which are based on the dynamic flow of plant genetic resources.

This article is structured as follows. The next section describes briefly the conceptual framework and the methodology of the study. It is followed by a brief review of previous studies of the relationship between intellectual property and plant genetic resources. Then follow three sections that summarize the main research findings: the management of germplasm in the context of climate change by CGIAR genebanks, by CGIAR plant breeding programmes, and the role of intellectual property in relation to the germplasm management by genebanks and breeding programmes. The concluding section synthesizes the main results and makes a suggestion for additional research.

Conceptual framework and methodology

The international agricultural research system is made up of international research agencies, national agricultural research agencies, universities and academies, private sector entities, and non-government organizations. The CGIAR, a network of 15 research Centres with offices and experimental stations spread across the globe, operates at the international level. Our study focused on the uses of plant genetic resources according to the patterns of flow into, within, and out of the CGIAR Centres. The two main units within each CGIAR Centre that 'move' germplasm are the genebank and the breeding programme. Genebanks acquire, analyse, conserve, and redistribute germplasm, while breeding programmes acquire, analyse, use and distribute (improved) germplasm. The international agricultural research system operates in a wider, external institutional context which includes international and national policies and laws (e.g. concerning agricultural biodiversity, plant genetic resources, seed production and

marketing, trade of agricultural products, technology development and transfer, intellectual property rights), funding priorities, capacities and rules of donor agencies, and programming agendas of development agencies. It is also influenced by forces, events and changes in the global biophysical environment (e.g. natural disasters) driven by climate change. Internal to the international agricultural system is the CGIAR's own institutional framework since recently guided by a common Strategy and Results framework and research programmes.

Combining an innovation systems' with a social actor approach (Leeuwis 2004; Vernooy and Song 2004), we analysed the institutional and organizational structures and mechanisms through which knowledge and germplasm are generated and disseminated among the actors at various levels and locations. The institutional analysis was combined with an analysis of how the key social actors, in this case, genebank managers, breeders, intellectual property right (IPR) specialists, extension agents, NGO staff, and farmers, actively take part in and make decisions about the use, management, and conservation of germplasm.

A total of 70 personal interviews with scientists from 8 CGIAR Centres were conducted over the period of July to November 2011. Interviewees included 29 plant breeders, 8 policy and legal specialists, 8 genebank managers, and 25 other scientists (natural resource management scientists, geographic information systems specialists, social scientists). A questionnaire was used for the interviews which had a set of common questions for all interviewees and subsets of questions for each of the four categories of professionals. Interview notes were recorded in a common comparable Excel format and complemented by summaries (provided by the interviewers) of the most salient issues that arose over the course of interviews with scientists in the same Centre. In addition, journal articles, reports and other documents pointed out as relevant by the interviewees were collected and reviewed. To complement the interviews and received secondary literature, literature reviews were undertaken on the following topics: priorities of CGIAR Centres' breeding programmes; strategies and channels for the dissemination of improved germplasm of CGIAR Centres; factors influencing uptake of crop technologies, such as subsidies; the impacts of intellectual property rights and access and benefit sharing policies on agricultural research; and CGIAR Centres' collaboration with the private sector. Detailed study results can be found in a working paper distributed by the CCAFS programme of the CGIAR (López-Noriega et al. 2012).

The impact of intellectual property on access and use of plant genetic resources

Academic and development policy debates concerning access to and use of plant germplasm and technologies subject to intellectual property rights have been documented extensively in the literature since the 1980s (Aoki 2004; Lamola 1992; Maskus and Reichman 2004; Mooney 1979; Primo Braga and Fink 1997). Discussions became particularly inflamed following the adoption in 1994 of the agreement on Trade-Related aspects of Intellectual Property Rights (TRIPS), which requires all member countries of the World Trade Organization to adopt minimum standards of intellectual property protection of plant varieties either by patents or by an effective sui generis system or by a combination of the two (TRIPS Article 27.3 (b); (Roffe 2008). Arguments in favor and against the use and expansion of IPRs continue. Tansey, in a comprehensive review of intellectual property on the various components of food systems globally (from production to marketing), warns that the expansion of intellectual property in

particular through patents will have negative implications on the control of food in particular through restricting access to seeds and related knowledge (Tansey 2008). Other authors argue the opposite. For example, Grimes et al., state that while the mechanisms for IPR establishment exist in the developing world, they are under-utilized and sometimes poorly understood, thus, rendering them either ineffective or counter-productive. They conclude that IPR is critical to the agricultural development needed to meet the demands of a growing population, but that policy and regulation changes are necessary to efficiently promote such development (Grimes et al. 2011).

More recently, some attention has been paid to understanding the implications of using IPRs to protect technologies that hold promise for mitigating and/or adapting to climate change. This issue is being debated as part of international trade and IP negotiations in such fora as the WTO, WIPO, and groups that negotiate bilateral and regional trade agreements. A study by the International Council on Human Rights Policy (2011) observes that technology transfer has been stalled on the issue of IP rights for too long. The study argues that policy technology need not pivot entirely on IP rights, and the inclusion of patent pooling or open licensing requirements will not only be appropriate, it will also be efficient and will fit well within existing IP protections. Two studies with reference to climate tolerant plant varieties (ETC Group 2010) and climate related technologies more broadly (Shashikant and Kohr 2010) express concerns about the increasing concentration of technology in the hands of a few actors. The ETC Group study documents recent attempts by multinationals to restrict access to promising germplasm and technologies through the use of patent claims. The study argues that public research institutions and farmers will suffer as a result. Although the ETC report focuses on practices of multinationals, it also refers to the CGIAR. The report questions in particular how the CGIAR is dealing with issues of ownership and control of drought-tolerant genes being used in climate change oriented breeding activities (ETC 2010: 23-24).

Prior research has shown simultaneous growth of applications for patents and plant breeders' rights seeking control of the exploitation of plants, plant varieties, and their seeds. This has been particularly evident in developed countries and emerging economies (Koo et al. 2004; López-Noriega 2013). Applications by public research agencies account for a considerable degree of this increase. In China, for example, plant breeder's right applications increased from a yearly number of around 100 in 1999 and 2000 to over a 1000 in 2009 (Li 2012). The literature criticizes in particular the monopolistic USA patent system, which, unlike most of European and other countries' patent and plant variety protection (PVP) laws, does not provide for a form of exemption in case of research (Ghijsen 2009; Tripp et al. 2010).

In an earlier study, (Jaffé and Van Wijk 1995) researched experiences of breeders and farmers in Argentina, Chile, Colombia, Mexico, and Uruguay. The authors concluded that the introduction of plant variety protection systems in these countries has had a positive effect on access to elite materials generated by seed companies in developed countries, in particular hybrid lines of major grains and improved propagating material of ornamental plants and fruit trees (Jaffé and Van Wijk 1995). A study conducted by the Union for the Protection of Plant Varieties (UPOV) in Argentina, China, Kenya, Poland and Republic of Korea arrives at a similar conclusions, for the same species (UPOV 2005).

Focusing on the research and commercialization of protected plant germplasm of staple crops in developing countries, Koo et al. emphasize that concerns around IPRs are overstated (Koo et al. 2004). Although they agree that the scope and the geographical extension of protection is expanding, the preponderance of protection pertains to high and medium-high income countries, leaving poor countries free to tap these technologies. Moreover, a large share of the protected varieties is ornamentals, not food crops. Most plant varieties are afforded protection that enables rights holders to limit or exclude others from marketing, but not breeding with the protected material. This offers researchers in both developed and developing countries freedom to use them in their breeding activities. An in-depth review of the impact of intellectual property rights on the plant breeding industry in China, Colombia, India, Kenya and Uganda, did not lead to any clear conclusions concerning positive or negative impacts on access and use of plant genetic material (Louwaars et al. 2005).

The studies referred to above indicate that detailed empirical evidence of the precise impact of intellectual property protection on the management of plant genetic resources, in particular in developing countries, is scarce or does not lead to clear-cut conclusions. If and how this situation concerning the impact of intellectual property on plant genetic resources will change in the context of climate change is still unclear.

Germplasm flows in and out of CGIAR genebanks

The genebank managers, like many of the breeders interviewed (see the next section), expressed some skepticism about the increasing interest of donors and development agencies in climate change. They confirmed that many of the traits they have traditionally been working on are related to abiotic stresses due to climate (change) factors. When pressed, however, many of them identified some priorities that are linked to the impact of recent climate changes in particular areas of the world, such as increased occurrence of extreme weather events or suddenly more pronounced climate conditions which were uncommon in the past (e.g., floods and consequent waterlogging in wheat growing areas in South Asia, delay in the onset of the rainy season in the Bolivian highlands). Most notably, interest in collecting and characterizing wild relatives of some crops is increasing in the hope to find useful, so far undiscovered, traits of particular interest, for example, tolerance to extreme heat or cold.

Some CGIAR Centres have recently started to experiment with new approaches to linking both CGIAR and national genebanks to farmers, with the latter becoming direct recipients and sometimes evaluators of germplasm. Examples are the Sustainable Modernization of Traditional Agriculture or MasAgro project in Mexico led by CIMMYT and the Seeds for Needs project carried out in Ethiopia and Papua New Guinea led by Bioversity International. These projects represent novel and proactive ways to respond to climate change challenges.

Our study confirmed that germplasm flows into CGIAR genebanks have come under stress. Since 1992, the total of new acquisitions by CGIAR genebanks has experienced a downward trend. From a high of almost 40 000 in 1984 the number dropped to around 25 000 in 1992 to less than 5 000 in 2009. It is becoming increasingly difficult for most of the CGIAR genebanks to access new germplasm to include in their collections with the exception of materials from well-established genebanks in Europe and North America (Halewood et al. 2012). Managers of

CGIAR genebanks reported that joint missions with NAROs to collect genetic resources in situ for the CGIAR genebanks to conserve and distribute internationally have become a rarity. Some genebanks have on occasion been offered materials they requested under legal conditions that are too restrictive to be accepted. Some countries will deposit new materials in selected CGIAR genebanks only if they agree not to redistribute them or to do so only to germplasm users in countries which are parties to the International Treaty on Plant Genetic Resources for Food and Agriculture. A number of national institutions are coordinating their own fairly extensive collecting missions, but so far very little (perhaps none) of the collected material appears to be available to recipients outside the countries concerned, including CGIAR genebanks.

The genebank managers attributed part of these difficulties to high levels of politicization of genetic resources issues, to inappropriate policy initiatives including national legislation on access and benefit sharing inspired by the Convention on Biological Diversity, and to pressures to globalize intellectual property rights protection through international trade agreements. Some of the respondents thought that the ITPGRFA and its Multilateral System (MLS) of access and benefit sharing, after a slow start in 2007, have gradually become more effective. Some thought that the Treaty might have made things worse, because of the perceived complexity of implementing the MLS at national level or because the crops they wanted to access were not included in the MLS.

The relative importance of the lack of access to new germplasm appears to be tempered for some crops by the fact that a) there is already considerable unexplored germplasm in the Centres' genebanks, or that b) the Centres' breeders already had a fair amount of improved materials at their disposal. On the other hand, most of the genebank managers and several breeders confirmed that over time this diversity will not be sufficient to deal with new stresses that will occur, including those induced by climate change, particularly for some crops. Some of them expressed concern about this.

Levels of distributions of samples from the genebanks have experienced a gradual downward trend over the last 15 years in response to more targeted requests from recipients and the ability of Centres to better identify specific sample sets. At the same time, the literature confirms that the CGIAR Centres (genebanks and breeding programmes) continue to be by far the largest source of germplasm for national agricultural research organizations, and that bilateral, country-to-country transfers are minimal (Wang 2012).

CGIAR Breeding programmes

The CGIAR Centres have been breeding improved materials in response to abiotic stresses for a long time. Several of the interviewed CGIAR breeders expressed similar skepticism as genebank managers about the recent trend by donors and research and development organizations to place so much emphasis on climate change. Nonetheless, most of the breeders were able to identify some new breeding activities and use of new technologies directly linked to climate change challenges, such as increased drought, more extreme temperatures, more wide-spread flooding, higher levels of salinity, and shifting patterns of pest and disease occurrence.

In recent years, many of the CGIAR Centres have adopted new collaborative forms of germplasm development and diffusion involving various kinds of partners. Participatory approaches to crop improvement have made some inroads, in particular through participatory variety selection, in collaboration with NAROs and NGOs. Some of this work has a climate change adaptation focus, especially in terms of speeding up the adoption of adapted material to local conditions.

Some CGIAR Centres are developing parental lines to be used by private companies for the development of hybrid varieties. Other CGIAR Centres, in collaboration with NAROs, are working directly with farmers' groups and non-governmental organizations to select and get quality seed of the most promising open-pollinated varieties (OPVs) multiplied and distributed to farmers. This direction is often pursued to respond to the observed lack of capacity by the public or private sectors to ensure that quality seed of a variety of crops reaches farmers, in particular the poorest and those living in more marginal areas. Several breeders reported that their recent partnerships with the private sector in the context of hybrid consortia are leading to uptake and diffusion of improved technologies that were not otherwise possible.

In between the two strategies summarized above, a number of variations exist, for example, large research consortia in which the CGIAR Centres partner with public and private organizations, wherein public organizations are involved in developing and promoting OPVs and companies are involved in the development and diffusion of hybrids. These consortia with their wide range of partners and shared roles and responsibilities are occurring with increasing frequency.

Climate change adaptation strategies alone are not driving the changes in operational strategies. Instead, the changes are mostly brought about by the recent shift in international development culture toward achieving impact: the need to provide farmers with tangible, measurable ways to improve their production systems. The newly adopted CGIAR Strategic Results Framework with its commitment to 'managing for results' underscores the commitment of CGIAR Centres to reforming their work along these lines.

The new operational strategies increasingly confront the CGIAR Centres with a range of policy-related challenges. The new upstream research focus on development of technologies to be used and released by private companies requires them to strike delicate policy balances between providing incentives for private sector engagement and maintaining maximum public availability of the goods the CGIAR Centres develop. In some cases, the CGIAR Centres and their partners appear to have struck a balance relatively easily. In other cases, there has been public controversy. Generally, CGIAR Centres did not identify significant challenges associated with getting access to proprietary technology from companies and research institutions. Instead, most of the difficult intellectual property related issues arise in those situations where CGIAR Centres are providers of technologies to private sector companies.

The long and relatively difficult process to develop a CGIAR system-wide policy addressing these issues is testimony to their complexity and contentiousness. Now that the CGIAR

Principles on the Management of Intellectual Assets ('CGIAR IA Principles'¹) have been accepted by the CGIAR Fund Council and the Consortium of CGIAR Centres, at least the outer-parameters or limits of the kinds of arrangements that CGIAR Centres can make with private sector partners concerning assignment of exclusive rights for CGIAR Centre-improved materials are clearer.

The increased downstream involvement of many of the CGIAR Centres in enhancing seed systems for the production and availability of quality seed brings increased exposure to national level policies (or lack thereof), which influence the success of activities. Most relevant policies in this context concern national regulations dealing with variety registration, seed production, quality control and marketing, and subsidies. Concerns exist about the limited dissemination of a wider portfolio of crop species, particularly those which tend to be hardier and more resilient to climate extremes. CGIAR Centres involved in breeding these crops are developing closer interactions with (organized) farmers. In some cases, it has also led to the development of alternative variety release, dissemination and quality assurance schemes which involve small scale seed producer groups and use of informal channels of multiplication and exchange.

Many breeders expressed concerns about their inability to access (new) plant genetic resources. They stressed the difficulties related to getting access to and use materials from public research organizations or from private companies, although the situation is different depending on the centre, the potential provider organization and the crop. Some breeders and officers in charge of intellectual property issues reported being sent materials subject to legal conditions so restrictive that the centre could not accept them. Breeders in some CGIAR Centres described the movement of germplasm as having become one way: going out with nothing coming in.

The breeding programmes have traditionally made their improved germplasm available to anyone who asks for it. Since 2007, they have used the Standard Material Transfer Agreement (SMTA) adopted for the exchange of germplasm included in the Treaty's multilateral system of access and benefit-sharing. Recently, some of the CGIAR Centres have started distributing materials they improve with terms and conditions additional to those of the SMTA², most often to private sector recipients through mechanisms such as the hybrid consortia. These conditions include prohibitions on the ability of recipients to pass material on to third parties. Some companies and USA universities have indicated their discomfort receiving materials from the CGIAR Centres under the SMTA, but, in general, there appears to be a fairly widespread acceptance of the use of the SMTA by recipients around the world.

IPRs and the CGIAR

Some of the scientists and intellectual property specialists interviewed concurred that the existence of patents or intellectual property rights over a needed technology increases transaction costs. They pointed out that this could delay the access to and use of such technology in

¹ The principles were approved by the Consortium Board on 1 March 2012 and by the Fund Council on 7 March 2012. They are part of the Common Operational Framework as of 7 March 2012.

http://www.cgiarfund.org/cgiarfund/common_operational_framework

² The SMTA explicitly states that Providers can add complementary terms and conditions to those included in the SMTA when transferring 'PGRFA under Development'.

comparison to those technologies which are not subject to intellectual property protection. However, for the most part, CGIAR scientists and intellectual property specialists generally confirmed that intellectual property rights are not posing a significant hurdle for the CGIAR Centres to obtain access to technologies they need as inputs for their crop improvement efforts. They did not mention any particular IPR issue related to a climate change technology of interest to a Centre or to the CGIAR as a whole.

Several explanations were given for this situation. Most of the CGIAR Centres do not report actually needing to obtain or trying to obtain access to proprietary technologies for their crop improvement work. For some of the mandate crops of the CGIAR Centres, the private sector's investments in crop improvement is relatively low (e.g. millet, sorghum), with the result that companies are not generating elite material that might be protected. Indeed, it seemed that the contrary is often the case: it is the CGIAR Centres that are producing improved germplasm that the private sector wants access to, for example, parental lines for commercial hybrids (e.g. maize, rice).

Increased involvement of the private sector in the dissemination of new CGIAR germplasm – clearly a trend that emerges from the study – has raised issues related to intellectual property rights over what were traditionally considered global public goods. The establishment of hybrid consortia includes payments to CGIAR Centres (in the form of fees) in exchange for access to improved materials, under a variety of conditions. Some CGIAR Centres have received royalties from industry use of advanced germplasm, for example, in the case of cassava.

The approach to partnerships, particularly regarding issues related to intellectual property rights, has not been consistent across the CGIAR (CGIAR ADE-PSC 2009). Some CGIAR Centres address contractual obligations and particularly intellectual property rights, in a more formalized, systematic manner. Others do not have a specific procedure or policy, but act on a case by case basis. IRRI is currently developing a Centre-wide policy which includes the payment of royalties if IRRI improved material is used for commercial purposes.

All interviewees stressed that ensuring wide dissemination of technologies is the inspiring principle behind all dissemination strategies. But, they pointed out, in order to ensure it and at an affordable price, CGIAR Centres sometimes need to accept restrictions that compromise their public mandate. The recently approved CGIAR Intellectual Assets Strategy sets the rules for all CGIAR Centres concerning the conditions under which CGIAR Centres may restrict availability to their assets (including germplasm), the kinds of restrictions they may use, and how to apply public disclosure. The Strategy is expected to bring order in the range of practices that currently exist. An inter-centre working group has been set up to assist CGIAR Centres with the actual implementation of the Strategy.

Conclusions

There is growing consensus that a dynamic and open system of international research related to plant genetic resources will be instrumental for adapting agriculture to climate change. In recent years, the CGIAR Centres with crop breeding activities and programmes have initiated new forms of interdisciplinary research, using new technologies and novel combinations of

partnerships. These new research directions have only partially been influenced by the climate change related challenges that have appeared on the international development agenda.

The new CGIAR research directions have led to a series of policy and legal questions concerning access and use of germplasm and related technologies, in particular with regards to the role of the private sector. Until now, CGIAR Centres have not had a clear and consistent approach to deal with IPR issues, but a new system-wide policy has recently been approved. The study does not provide evidence that climate change per se is leading to any particular new policy and legal issues including in terms of intellectual property.

The institutional environment in which the CGIAR operates is changing. The study points to an increasing influence of international and national policies and legal frameworks on all the operations of CGIAR Centres from upstream to downstream. It appears that, broadly speaking, the institutional environment is becoming less supportive for the efforts of CGIAR Centres and their partners to continuously access, use and disseminate genetic resources. An increasingly restrictive institutional environment may, in the longer term, have a serious impact on the development of (new) strategies to adapt to climate change based on the use of plant genetic resources.

The CGIAR, although operating in this changing institutional environment, has an important role to play: to make sure that the strategies it deploys to adapt to climate change are and will remain dynamic and open. This implies an active stance to avoid the concentration of germplasm and related technologies in the hands of a few. Further research is warranted to effectively implement practices that would lead CGIAR Centres to not have to restrict availability to the germplasm and related technologies they hold in trust.

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